

01/28/2002

Interim Progress Report

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Name of Recipient Organization: University of Washington

Principal Investigator: John K. Horne

Project Title: Acoustic Characterization of Steller Sea Lion Forage Species

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Award Period: From 07/01/2001 to 06/30/2003

Period Covered by this report: From 07/01/2001 to 01/01/2002

Project Summary

The decline of western Aleutian Steller sea lion populations over the last decade is well documented. Many of the hypotheses proposed to explain this decline include access to and consumption of fish as prey. Distributions, abundance, and classifications of fish in the Gulf of Alaska and Bering Sea are routinely estimated using underwater acoustics. To accurately depict the prey field of Steller sea lions, acoustic targets must be categorized in functional groups or ideally, species.

In this project, Kirchhoff-ray mode backscatter models are used to quantify acoustic characteristics of Bering Sea and Gulf of Alaska fish species. Primary effort will focus on Steller sea lion 'forage' species: capelin, eulachon, and Pacific herring. Potential discrimination among species will be evaluated by comparing forage fish acoustic characteristics to other dominant species including walleye pollock and Atka mackerel. This project will result in the description and visualization of backscatter properties (i.e. amplitude, variance) for each species and recommendations on frequency choice and technique to maximize probability of acoustic species discrimination.

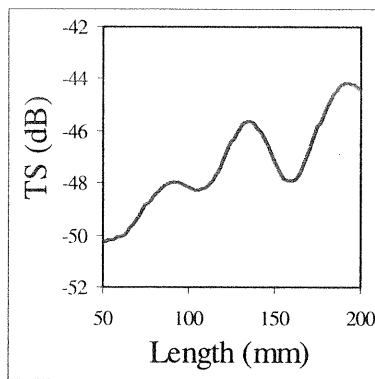
Summary of Progress and Results

In the first part of this project we have collected several samples of the species of interest. We have collected a total of 50 specimens of juvenile and mature Walleye pollock (*Theragra chalcogramma*), 16 specimens of eulachon (*Thaleichthys pacificus*), 10 specimens of Atka mackerel (*Pleurogrammus monopterygius*), and 1 specimen of Pacific herring (*Clupea harengus*).

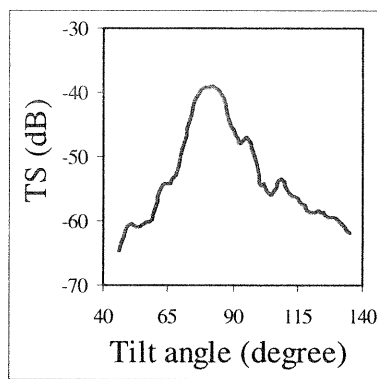
Live fish were surface-adapted in tanks. Individuals were anesthetized with a 60 ppm solution of clove oil and radiographed using a portable veterinary x-ray unit. The silhouettes of the fish body and swimbladder (when present) were traced from the radiographs on acetate sheet. The maximum and minimum length and depth of the body and swimbladder were recorded to the nearest 0.5 mm, and the resulting silhouette images were scanned into a computer graphics program. Separate digital images were created for the dorsal and lateral body views, as well as the dorsal and lateral swimbladder traces. Orientation of the swimbladder relative to the body was maintained. A digitizing program reads the traces and scales body parts to their true size using maximum and minimum measurements. If necessary, traced lines were rotated so that the sagittal axis of the fish body lies along the x-axis.

We used the the Kirchhoff-ray mode (KRM) model to estimate acoustic backscatter. The KRM model partitions fish body and swimbladder anatomy into separate finite cylinders, computes backscatter from each cylinder, and then sums backscatter over all cylinders. Below are a series of graphics to illustrate the effects of fish length (L), orientation (tilt angle), and carrier frequency (f) on backscatter amplitudes for each of the species collected. Mean acoustic backscatter for each group is presented in the more familiar format of target strength (TS).

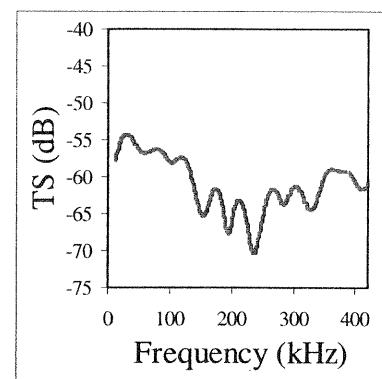
Juvenile Walleye pollock (n = 5)



$f = 120 \text{ kHz}$
Tilt = 90°

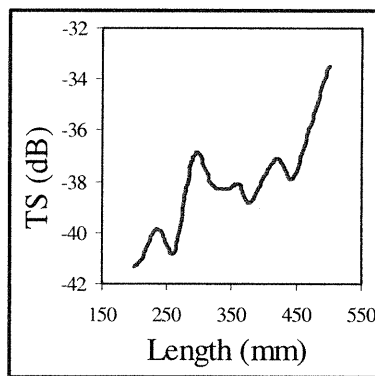


$L = 130 \text{ mm}$
 $f = 120 \text{ kHz}$

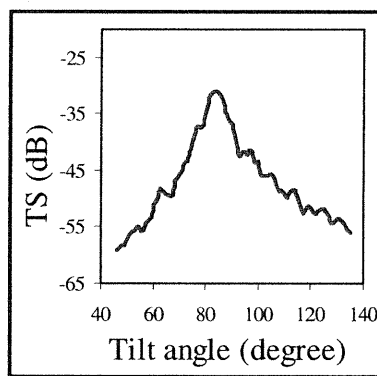


$L = 130 \text{ mm}$

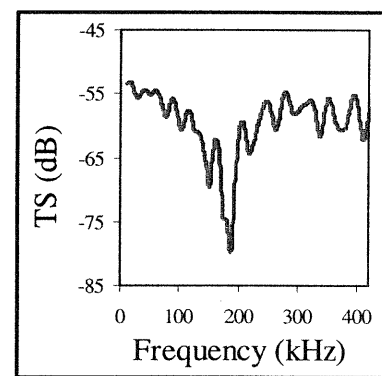
Mature Walleye pollock (n = 10)



$f = 120 \text{ kHz}$
Tilt = 90°

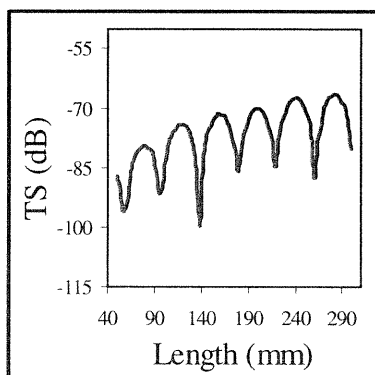


$L = 300 \text{ mm}$
 $f = 120 \text{ kHz}$

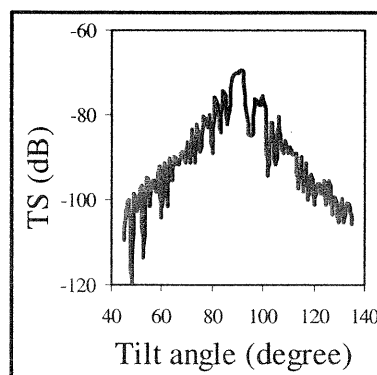


$L = 300 \text{ mm}$

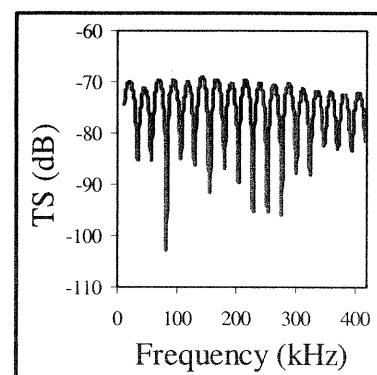
Eulachon (n = 16)



$f = 120 \text{ kHz}$
Tilt = 90°

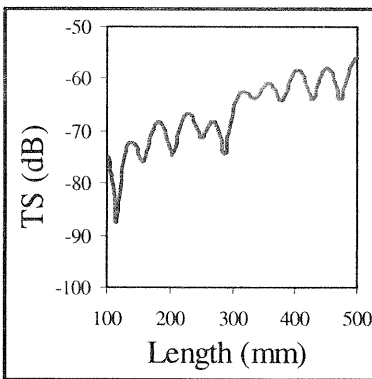


$L = 200 \text{ mm}$
 $f = 120 \text{ kHz}$

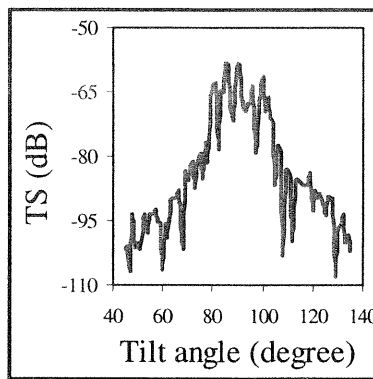


$L = 200 \text{ mm}$

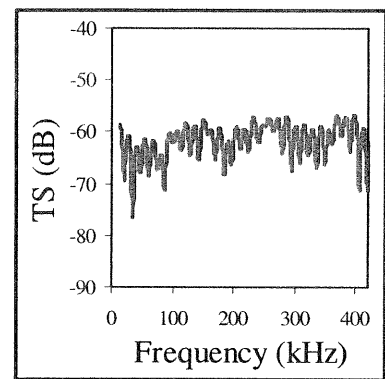
Atka mackerel (n = 10):



f = 120 kHz
Tilt = 90°

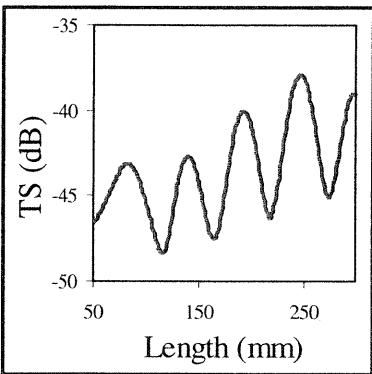


L = 400 mm
f = 120 kHz

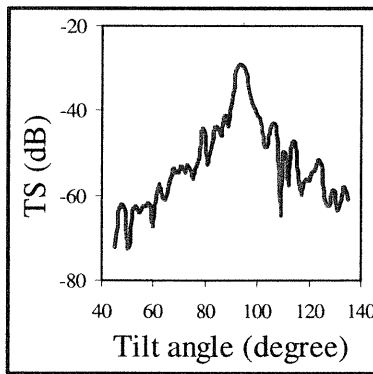


L = 400 mm

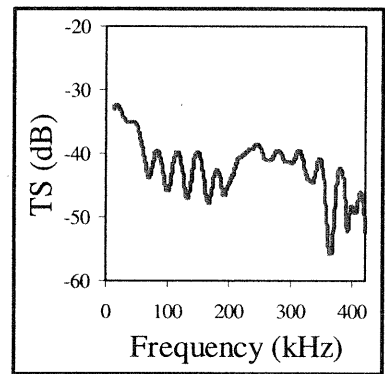
Pacific herring (n = 1)



f = 120 kHz
Tilt = 90°



L = 200 mm
f = 120 kHz



L = 200 mm

Differences in echo amplitudes and variability can be observed among species. The estimated echo-amplitude of 200 mm Walleye pollock was lower for juvenile fish. When estimated using radiographs of mature fish, the amplitude was 2-3 dB higher. The absence of a swimbladder in Atka mackerel and eulachon results in lower amplitudes. The small size of eulachon combined with the absence of a swimbladder results in more variability of TS across frequencies (successive peaks and troughs). The maximum TS of Walleye pollock and Pacific herring occurred at a different orientation than 90° because of the angle of the swimbladder relative to the longitudinal (i.e. sagittal) axis of the fish.

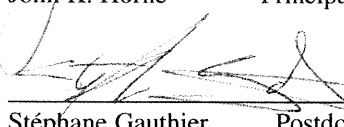
Problems

No problems have been encountered. We will attempt to collect specimens of Pacific capelin and Pacific herring in upcoming field work.

Prepared by:

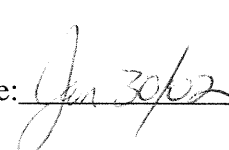

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Date:



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